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Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

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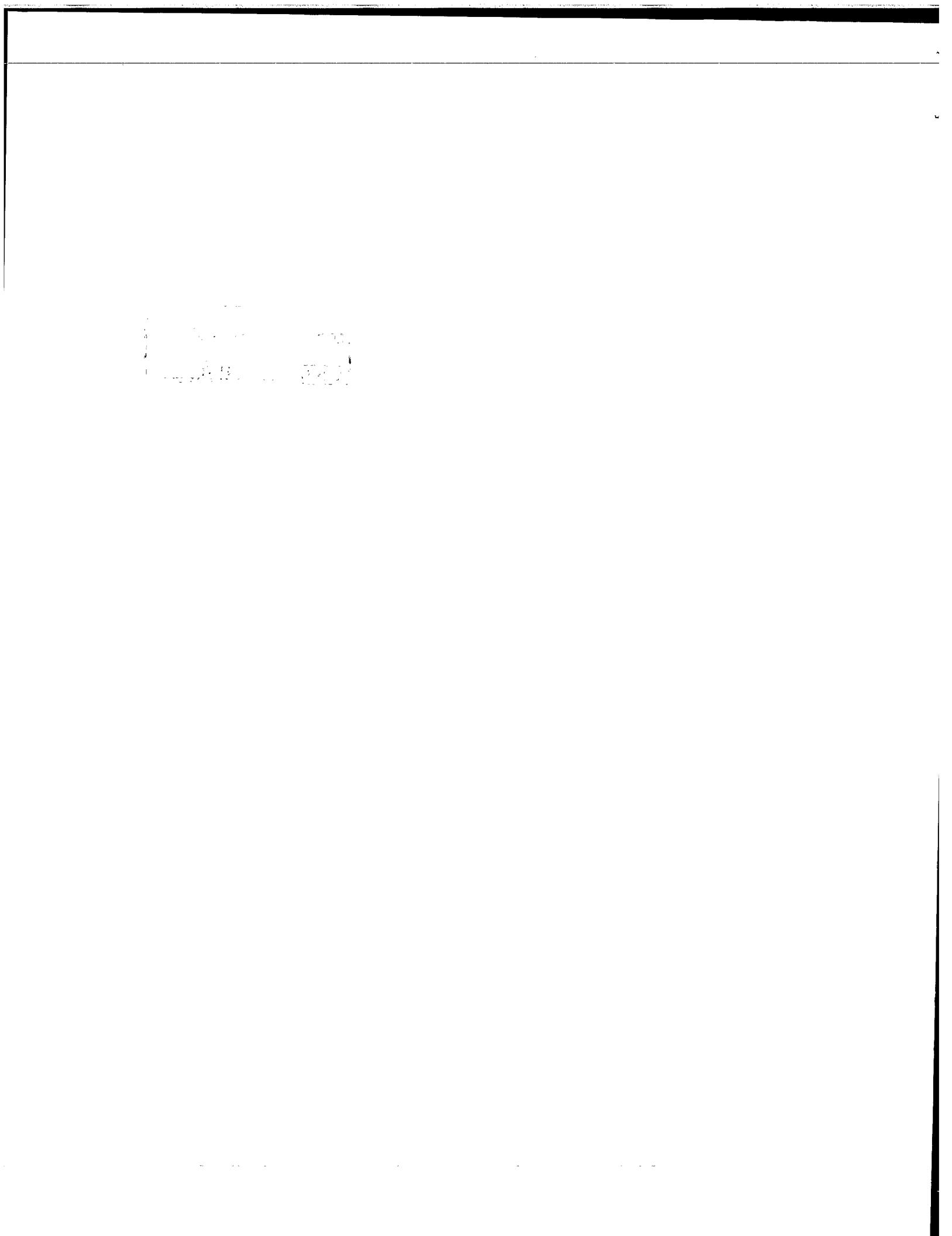
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Encoding method and decoding method and encoding apparatus for a digital picture sequence

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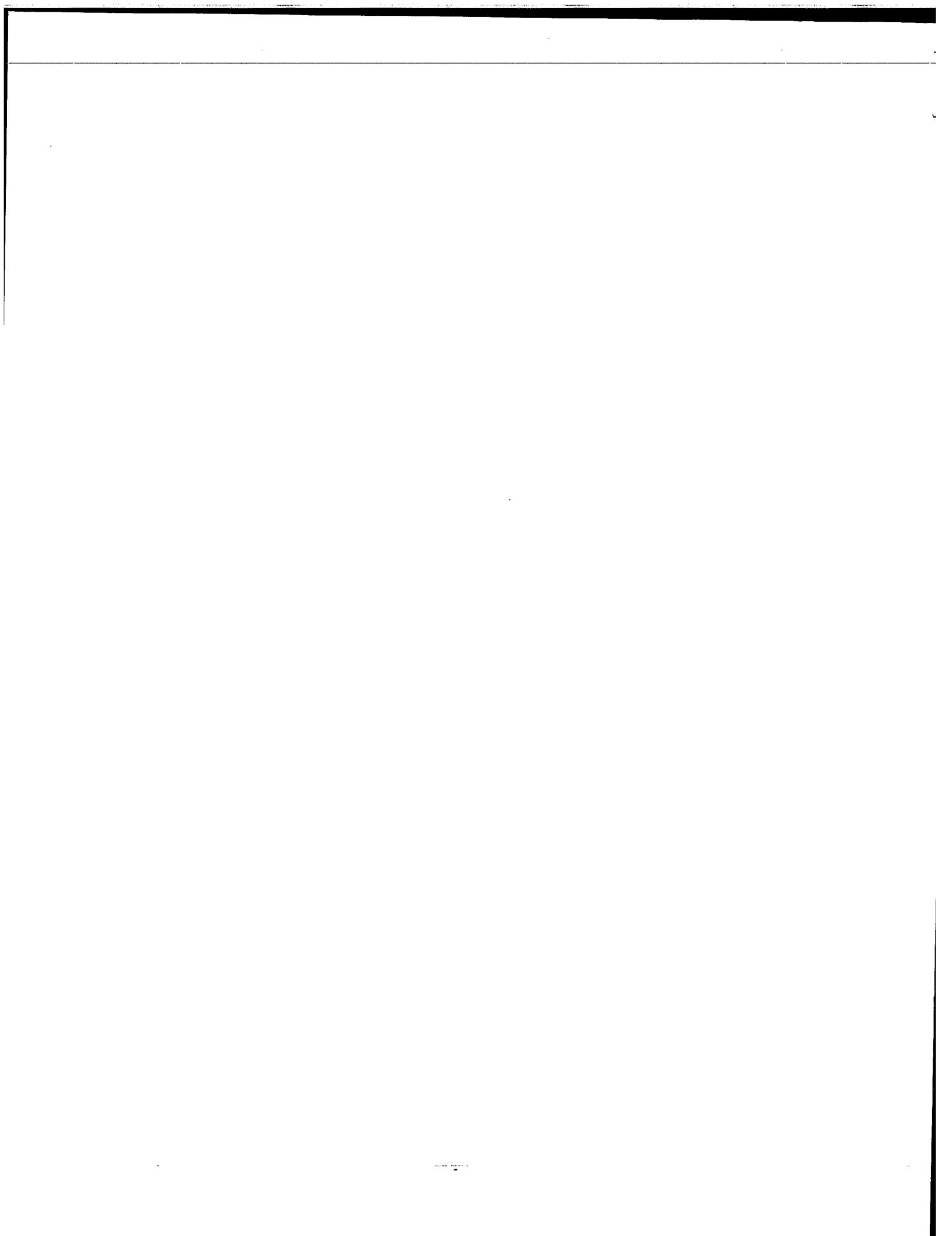
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**Encoding method and decoding method and encoding apparatus
for a digital picture sequence**

The invention relates to an encoding method and a decoding
method and to an encoding apparatus for a digital picture
sequence, wherein the frames of said picture sequence are
arranged in macroblocks containing pixel blocks and the
frames are encoded using B, P and I coding types.

10

Background

Video sequences generally contain widely varying picture
content and previously coded frames are used to predict a
15   current frame. In block-based hybrid video coders such as
ITU-T and ISO/IEC JTC1, "Generic coding of moving pictures
and associated audio information – Part 2: Video", ITU-T
Recommendation H.262 – ISO/IEC 13818-2 (MPEG-2 Visual), Nov.
1994,
20   ITU-T, "Video coding for low bitrate communication," ITU-T
Recommendation H.263, version 1, Nov. 1995, version 2, Jan.
1998,
ISO/IEC JTC1, "Coding of audio-visual objects – Part 2: Vis-
ual," ISO/IEC 14496-2 (MPEG-4 Visual version 1), Apr. 1999,
25   Amendment 1 (version 2), Feb. 2000,
T. Wiegand (ed.), "Joint Final Committee Draft (JFCD) of
Joint Video Specification (ITU-T Rec. H.264 | ISO/IEC 14496-
10 AVC)", Joint Video Team (JVT) of ISO/IEC MPEG and ITU-T
VCEG, JVT-D157, July 2002,
30   the distortion of a macroblock as well as the number of bits
required for encoding it is mainly controlled by the macro-
block's quantisation parameter. The general objective of a
rate control mechanism is to provide the best possible video
quality while keeping given conditions on transmission rate
35   and decoding delay. Typically, a rate control includes a
frame-layer control and a macroblock-layer control. In order

to achieve a constant video quality, the anchor frames and
the non-anchor frames of different coding types (I (intra-
coded), P (predictive coded) and B (bi-directionally-
predictive coded)) must be encoded using a different numbe:

5   of bits for each coding type. E.g. in MPEG-2 Visual, the
code for an encoder input frame that is to be encoded as P
type, which frame is at encoder input preceded by a frame
that is to be encoded as B type, is output by the encoder
before the code for the B frame is output because the P

10 frame must be reconstructed in the decoder before the B
frame can be reconstructed based on the reconstructed P
frame. While the frame-layer control assigns a target numbe
of bits for a frame so that the conditions on transmission
rate and decoding delay are kept, the macroblock-layer con-

15 trol selects the macroblock quantisation parameters in a wa
that this target is achieved.

A widely used method for setting the target number of bits
when coding different frame types is the frame-layer rate

20 control as specified in Test Model 5 (ISO/IEC JTC1/SC29/
WG11/N0400, "Test Model 5, Draft Revision 2", April 1993).
This document describes an encoder strategy for MPEG-2 Vis-
ual. The assignment of frame targets is based on so-called
global complexity measures. For each frame type (I, P, B)

25 there exists a specific complexity measure, which is update
after the encoding of each frame of the respective frame
type. The target number of bits for each frame is determine
by weighting the number of available bits for (the remainir
frames of) a group of pictures using these global complexit

30 measures.

Invention

35 However, this concept has a general disadvantage in that a
reasonable distribution (with the objective of constant su

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jective video quality) of the available bit budget to dif-
ferent frame types is not feasible since the decision is
based on measurements for a different interval of time. In
particular, the frame targets for bi-directionally coded
5   frames (or, more general, non-anchor frames) are difficult
to determine, and if applied to more recent video coding
standards like H.263 (with Annex O), MPEG-4 Visual or H.264/
AVC, the problem arises that the macroblock-layer rate con-
trol for non-anchor frames becomes ineffective especially at
10   low bit-rates, because a large fraction of the macroblocks
is coded without transform coefficients and thus the macro-
block quantisation parameters cannot reasonably be adjusted.

In applications requiring a very low decoding delay the cod-
15   ing order of frames should be the same as the display order,
hence 'classical' B frames as defined in MPEG-2 Visual,
H.263 (with Annex O), or MPEG-4 Visual cannot be used. In
JVT/H.264 the concept of bi-directional B pictures is gener-
alised to bi-predictive B pictures, but 'classical' bi-
20   directional pictures are still supported. For such class of
very low-delay applications, the global rate control algo-
rithm must assign a nearly constant target number of bits to
each frame.

25   In applications which do not require a very low decoding de-
lay, the main objective of the frame-layer rate control is
to assign the frame bit number targets versus the different
frame or picture types in such a way that a constant subjec-
tive video quality level is kept over the different frame or
30   picture types. In real-time applications that do not allow a
complex analysis or a pre-coding of several frames, this
decision is to be made on the basis of previously coded
frames. However, due to the widely varying picture content
of video sequences, decisions based on a different interval
35   of time are often unsuitable, and due to the fact that one
or more previously coded pictures are used for predicting a

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given picture, there is no simple model that can be used for
determining the related optimum target number of bits for
different frame types. Especially if non-anchor frames are
used, a reasonable distribution of the bit budget among the
5 different frame types cannot suitably be estimated.

A problem to be solved by the invention is to provide an im-
proved bit rate control such that a constant subjective
video coding or decoding quality over different frame or
10 picture types is achieved. This problem is solved by the en-
coding method disclosed in claim 1 and by the decoding
method disclosed in claim 10. An apparatus that utilises
this encoding method is disclosed in claim 2.

15 The invention concerns frame-layer rate control for applica-
tions in which the delay constraint is relaxed so that the
frames of a video sequence need not be encoded in the dis-
play order that is output at decoder side, and wherein the
target number of bits for a group containing one anchor
20 frame and several non-anchor frames (e.g. 'B..BP' in the
classical B-frame case) is not required to be constant.

According to the invention, the problem of assigning before
encoding a target number of bits to frames of each type is
25 circumvented. Instead, non-anchor frames are encoded using a
fixed quantisation parameter, and no macroblock-layer rate
control is used. The quantisation parameter used for the en-
coding of non-anchor frames or a single non-anchor frame in
a current group of frames is directly derived from the aver-
30 age quantisation parameter of the previously encoded anchor
frame belonging to that group (which anchor frame will fol-
low that non-anchor frames in display order at decoder
side). Thereby, advantageously, a nearly constant (objec-
tive) video quality can be ensured. The distribution of the
35 bit budget among different frame types can be controlled by
setting suitable target rates for the anchor frames only.

5

A high-level global rate control must only assign a target
number of bits to the above-mentioned frame or picture
groups consisting of a single anchor frame (picture) and
several non-anchor frames (pictures) which follow that an-
5   chor frame (picture) in coding order and precede it in dis-
play order, e.g. 'B...BI' and 'B...BP' in the classical B
frame case. This kind of bit distribution can be controlled
significantly easier than the known separate bit distribu-
tion among frames including all coding types I, P, and B.
10   In other words, non-anchor frames are coded using a fixed
quantisation parameter. Since the quantisation parameter
used for the encoding of non-anchor frames is directly de-
rived from the average quantisation parameter of the previ-
ously encoded anchor frame, such approach ensures a constant
15   video quality. Beside of that, the complexity of the rate
control strategy is reduced, because no macroblock-level
rate control is applied for the encoding of non-anchor
frames.

20   In principle, the inventive encoding method is related to
digitally encoding a picture sequence, wherein the frames of
said picture sequence are arranged in macroblocks containing
pixel blocks and the frames are encoded in bi-directionally-
predictive and predictive and/or intra coding types denoted
25   B, P and I, respectively, and wherein adaptively, for the
purpose of overall bit rate control, a specific frame target
number of bits is assigned to each one of these coding
types, and wherein said overall bit rate control includes a
frame-layer rate control and a macroblock-layer rate control
30   which macroblock-layer rate control selects macroblock quan-
tisation parameters, said method including the steps:
- assigning a target number of bits to anchor frames only,
or to each group of frames consisting of a single anchor
frame and at least one non-anchor frame;
35   - coding anchor frames using macroblock-layer rate control
by adaptive macroblock quantisation parameters, and coding

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non-anchor frames without macroblock-layer rate control by
using fixed macroblock quantisation parameters.

In principle the inventive encoding apparatus is suited for
5   digitally encoding a picture sequence, wherein the frames of
said picture sequence are arranged in macroblocks containing
pixel blocks and the frames are encoded in bi-directionally-
predictive and predictive and/or intra coding types denoted
B, P and I, respectively, and wherein adaptively, for the
10 purpose of overall bit rate control, a specific frame target
number of bits is assigned to each one of these coding
types, and wherein said overall bit rate control includes a
frame-layer rate control and a macroblock-layer rate control
which macroblock-layer rate control selects macroblock quan-
15 tisation parameters, said apparatus including:
    - means for assigning a target number of bits to anchor
frames only, or to each group of frames consisting of a sin-
gle anchor frame and at least one non-anchor frame;
    - means for coding anchor frames using macroblock-layer
20 rate control by adaptive macroblock quantisation parameters,
and for coding non-anchor frames without macroblock-layer
rate control by using fixed macroblock quantisation parame-
ters.

25 In principle, the inventive decoding method is related to
digitally decoding an encoded picture sequence, wherein the
frames of said picture sequence are arranged in macroblocks
containing pixel blocks and the frames were encoded in bi-
directionally-predictive and predictive and/or intra coding
30 types denoted B, P and I, respectively, and wherein adap-
tively, for the purpose of overall bit rate control, a spe-
cific frame target number of bits was assigned to each one
of these coding types, and wherein said overall bit rate
control included a frame-layer rate control and a macro-
35 block-layer rate control which macroblock-layer rate control
had selected macroblock quantisation parameters,

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wherein a target number of bits was assigned to anchor
frames only, or to each group of frames consisting of a sin-
gle anchor frame and at least one non-anchor frame,
and wherein anchor frames were coded using macroblock-
5   layer rate control by adaptive macroblock quantisation pa-
rameters, and non-anchor frames were coded without macro-
block-layer rate control by using fixed macroblock quantisa-
tion parameters,
said method including the step of:
10   - decoding said anchor frames using correspondingly adap-
tive macroblock quantisation parameters, and decoding said
non-anchor frames using fixed macroblock quantisation pa-
rameters.

15   Advantageous additional embodiments of the invention are
disclosed in the respective dependent claims.

Drawing

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Exemplary embodiments of the invention are described with
reference to the accompanying drawing, which show in:
Fig. 1   Block diagram of an inventive encoder, including the
inventive coder control by a corresponding control
25   stage.

Exemplary embodiments

30   In Fig. 1 an input video signal IVS is fed to a subtractor
11, to a first input of a motion estimation stage 18 and to
a coder controller 10. The coding is based on frames FRM
which are split or partitioned into macroblocks MB each con-
taining e.g. 16*16 luminance pixels arranged in e.g. 4 lumi-
35   nance pixel blocks, and corresponding chrominance pixel
blocks. The output of subtractor 11 passes through a trans-

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form, scaling and quantisation stage 12 and a scaling, (cor-
responding) inverse quantisation and (corresponding) inverse
transformation stage 13 to an adder 14. Said transform is
preferably a DCT transform on pixel blocks. The quantised
5   transform coefficients QTC coming from stage 12 are also fed
to an entropy encoding stage 19. The output of adder 14
passes via an optional de-blocking filter 15 to a (macrob-
lock-based) motion compensation stage 17 and to a second in-
put of (macroblock-based) motion estimation stage 18,
10   thereby providing a decoded output video signal DOVS. Motion
compensation stage 17 receives the required motion data MD,
e.g. (macroblock-based) motion vectors, from stage 18. Stage
17 and/or stage 18 contain at least one picture memory. Ei-
ther the output of motion compensation stage 17 or the out-
15   put of an intra-frame prediction stage 16 is fed via a
switch SW to the subtracting input of subtractor 11 and to a
second input of adder 14. Coder controller 10 controls
stages 12, 13, 16, 17, 18 and switch SW. Corresponding con-
trol data CD and the motion data MD output from stage 18 are
20   also fed to entropy encoding stage 19 in which the data are
entropy encoded, including e.g. VLC (variable length encod-
ing) and side information multiplexing and possibly error
protection, leading to an encoded output video signal EOVS
to be transmitted or transferred. Stages 13 to 17 together
25   represent a decoder, i.e. the encoder includes a decoder op-
eration.

A high-level global rate control processing assigns, using
coder controller 10, a number of target bits $\hat{R}_{Group-BP}$ (or
30   $\hat{R}_{Group-I}$) for each group of frames that consists of an anchor
frame coded as P frame (in H.264 also B frame) or I frame
and several non-anchor frames, e.g. a 'B...BP' or 'B...BI'
group for the classical B frame case, whereby such group may
also include one B frame only instead of several B frames.
35   The high-level global rate control must take care that

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$\hat{R}_{Group-BP}$ or $\hat{R}_{Group-I}$ are set such that a nearly constant video quality is achieved in the encoded output video signal EOVS and in the correspondingly decoded video signal in a decoder, respectively. This can be achieved by controlling the image quality (e.g. in terms of the mean squared error) or the average quantisation parameter of already coded anchor frames.

The inventive rate control for the anchor and non-anchor frames inside a group of one anchor and several non-anchor frames uses two weighting factors, $f_{Group-BP}$ and $f_{Group-I}$, which are adaptively controlled during the encoding of a video sequence. These factors $f_{Group-BP}$ and $f_{Group-I}$ specify the estimated ratios of the number of bits used (denoted R_{NA}) for encoding a non-anchor frame to the number R_{A-BP} of bits required for encoding an anchor frame if it is coded as P/B-frames, or R_{A-I} if it is coded as I-frame:

$$f_{Group-BP} = \frac{R_{NA}}{R_{A-BP}}, \quad f_{Group-I} = \frac{R_{NA}}{R_{A-I}} \quad .$$

Definitions

A current frame is called an 'anchor frame' if all frames that were previously encoded before this current frame precede it in display order.

A current frame is called a 'non-anchor frame' if there exists at least one previously encoded frame that follows the current frame in display order.

Initialisation

For initialisation, at the beginning of a sequence the factors $f_{Group-BP}$ and $f_{Group-I}$ are set, e.g. by controller 10, to pre-defined values, e.g.

$$f_{Group-BP} = \frac{1}{2}, \quad f_{Group-I} = \frac{1}{10} \quad .$$

Determining the target rate anchor frames

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Given the number of target bits $\hat{R}_{Group-BP}$ (or $\hat{R}_{Group-I}$) for a group of an anchor and several non-anchor frames, these factors are used in controller 10 for assigning the frame target $\hat{R}_{A-BP}$ (or $\hat{R}_{A-I}$) for the anchor frame coded as P/B-frame

5   (or I-frame) inside the group:

Anchor frame is coded as P/B-frame: $\hat{R}_{A-BP} = \dfrac{\hat{R}_{Group-BP}}{(1 + N_{NA} \cdot f_{Group-BP})}$,

Anchor frame is coded as I-frame: $\hat{R}_{A-I} = \dfrac{\hat{R}_{Group-I}}{(1 + N_{NA} \cdot f_{Group-I})}$.

N_{NA} (with $N_{NA} \geq 0$) denotes the number of non-anchor frames
10 inside the regarded group of frames. The corresponding anchor frame is encoded using an accurate macroblock-layer rate-control with the target rate of $\hat{R}_{A-BP}$ (or $\hat{R}_{A-I}$), respectively.

If the anchor frame is coded as a pair of field pictures,
15 the local rate-control will distribute the frame target rate among the two field pictures.

Encoding non-anchor frames

The non-anchor frames of a group of an anchor frame and sev-
20 eral non-anchor frames are encoded using a fixed quantisation step size of $Q_{NA} \approx 1.2 \cdot \overline{Q_A}$, where $\overline{Q_A}$ denotes the average quantisation step size that was used for encoding the anchor frame of the corresponding group of one anchor and several non-anchor frames. This leads to the following relationships
25 for the quantisation parameters QP:

MPEG-2, H.263, MPEG-4: $QP_{NA} = \max\left(round\left(1.2 \cdot \overline{QP_A}\right), QP_{max}\right)$,

JVT/H.264: $QP_{NA} = \max\left(round\left(2 + \overline{QP_A}\right), QP_{max}\right)$,

where QP_{max} denotes the maximum quantisation parameter that is supported by the syntax. Note that the non-anchor frames
30 are transmitted after the corresponding anchor frame, although they are displayed first.

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Model update after encoding

After a group of an anchor frame and several non-anchor
frames has been encoded completely, the weighting factors
$f_{Group-BP}$ and $f_{Group-I}$ are updated in controller 10 if the
number of encoded non-anchor pictures is greater than zero.
First, a weighting factor for the just encoded group (with
continuously increasing index $n_{Group-BP}$ or $n_{Group-I}$) is de-
termined by

Anchor frame is P/B-frame: $\tilde{f}_{Group-BP}(n_{Group-BP}) = \dfrac{1}{N_{NA} \cdot R_{A-BP}} \cdot \sum_{k=1}^{N_{NA}} R_{NA}(k)$,

Anchor frame is I-frame: $\tilde{f}_{Group-I}(n_{Group-I}) = \dfrac{1}{N_{NA} \cdot R_{A-I}} \cdot \sum_{k=1}^{N_{NA}} R_{NA}(k)$,

with $R_{NA}(k)$ being the number of used bits for the k-th non-
anchor frame inside the group, and R_{A-BP} and R_{A-I} being the
number of bits used for encoding the anchor frames as P/B-
frame and as I-frame, respectively.

The weighting factors, which will be used for determining
the target fraction of the bit budget used for the anchor
frame of following groups, are calculated in controller 10
as an average value for the last e.g. five encoded groups of
one anchor frame and a non-zero number of non-anchor frames:

Anchor frame is P/B-frame:

$$f_{Group-BP} = f_{Group-BP}(n_{Group-BP}) = \frac{1}{\max(5, n_{Group-BP})} \cdot \sum_{i=\max(0, n_{Group-BP}-5)}^{n_{Group-BP}-1} \tilde{f}_{Group-BP}(i) \ ;$$

Anchor frame is I-frame:

$$f_{Group-I} = f_{Group-I}(n_{Group-I}) = \frac{1}{\max(5, n_{Group-I})} \cdot \sum_{i=\max(0, n_{Group-I}-5)}^{n_{Group-I}-1} \tilde{f}_{Group-I}(i) \ .$$

The fundamental difference to other frame-layer rate control
strategies is that the weighting factors $f_{Group-BP}$ and
$f_{Group-I}$ are used only for estimating a reasonable target
number of bits for the anchor frame inside a group of one
anchor and several non-anchor frames. The quality as well as
the number of bits used for encoding the non-anchor frames

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is only determined by the average quantisation parameter QP
of the corresponding anchor frame. Thus, a fairly constant
video quality is achieved while the number of bits used for
encoding non-anchor frames can vary.

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Usage of a single weighting factor
Especially if Intra frames are coded rarely, it is appropri-
ate that both weighting factors $f_{Group-BP}$ and $f_{Group-I}$ are
updated at the same time. This can be carried out by combin-
ing the inventive features with the above-mentioned high-
level rate control, which sets the target rates $\hat{R}_{BP}$ and $\hat{R}_{BI}$
for the 'B...BP' and 'B...BI' groups of pictures.
As an example, it is assumed that the high-level rate con-
trol assigns the target rates $\hat{R}_{Group-BP}$ and $\hat{R}_{Group-I}$ by using an
adaptively controlled weighting factor f_{BP-I}, which speci-
fies the estimated bit-rate ratio of anchor frames coded as
P/B-frames and anchor frames coded as I-frames ($f_{BP-I} = R_{A-BP}/R_{A-I}$) suitable for constant-quality encoding. The tar-
get rates $\hat{R}_{Group-BP}$ and $\hat{R}_{Group-I}$ are set by exploiting

$$\frac{\hat{R}_{Group-BP}}{1+N_{NA}\cdot f_{Group-BP}} = \frac{\hat{R}_{Group-I}}{f_{BP-I}+N_{NA}\cdot f_{Group-BP}} \quad .$$

This leads to the following relationship between the two
weighting factors $f_{Group-BP}$ and $f_{Group-I}$:

$$f_{Group-I} = \frac{f_{Group-BP}}{f_{BP-I}} \quad .$$

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The correspondingly inverse steps are carried out in a cor-
responding decoding of the encoded picture sequence.

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Claims

1. Method for digitally encoding (10 - 19) a picture se-
   quence, wherein the frames (FRM) of said picture sequence
5 are arranged in macroblocks (MB) containing pixel blocks
   and the frames are encoded in bi-directionally-predictive
   and predictive and/or intra coding types denoted B, P and
   I, respectively, and wherein adaptively, for the purpose
   of overall bit rate control, a specific frame target num-
10 ber of bits is assigned to each one of these coding
   types, and wherein said overall bit rate control includes
   a frame-layer rate control and a macroblock-layer rate
   control which macroblock-layer rate control selects mac-
   roblock quantisation parameters, said method including
15 the steps:
   - assigning (10) a target number of bits to anchor frames
     only, or to each group of frames consisting of a single
     anchor frame and at least one non-anchor frame;
   - coding anchor frames (P, I) using macroblock-layer rate
20 control (10) by adaptive macroblock quantisation (12) pa-
     rameters, and coding non-anchor frames (B) without mac-
     roblock-layer rate control (10) by using fixed macroblock
     quantisation (12) parameters.

25 2. Apparatus for digitally encoding (10 - 19) a picture se-
   quence, wherein the frames (FRM) of said picture sequence
   are arranged in macroblocks (MB) containing pixel blocks
   and the frames are encoded in bi-directionally-predictive
   and predictive and/or intra coding types denoted B, P and
30 I, respectively, and wherein adaptively, for the purpose
   of overall bit rate control, a specific frame target num-
   ber of bits is assigned to each one of these coding
   types, and wherein said overall bit rate control includes
   a frame-layer rate control and a macroblock-layer rate
35 control which macroblock-layer rate control selects mac-
   roblock quantisation parameters, said apparatus includ-

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ing:

- means (10) for assigning a target number of bits to anchor frames only, or to each group of frames consisting of a single anchor frame and at least one non-anchor
5   frame;

- means (11 - 18) for coding anchor frames (P, I) using macroblock-layer rate control (10) by adaptive macroblock quantisation (12) parameters, and for coding non-anchor frames (B) without macroblock-layer rate control by using
10   fixed macroblock quantisation (12) parameters.

3. Method according to claim 1 or apparatus according to claim 2, wherein the quantisation (12) parameter used for the coding of non-anchor frames in a current group of
15   frames is directly derived (10) from the average quantisation (12) parameter of the previously encoded anchor frame belonging to that group.

4. Method or apparatus according to one of claims 1 to 3,
20   wherein for the bit rate control for the anchor and non-anchor frames inside a current one of said groups a weighting factor $f_{Group-BP}$ or $f_{Group-I}$ is used, which weighting factors are adaptively controlled during the encoding of said picture sequence and specify the esti-
25   mated ratios of the number R_{NA} of bits used for encoding a non-anchor frame to the number R_{A-BP} of bits required for encoding an anchor frame if it is coded as P or B frames, or R_{A-I} if it is coded as I-frame:

$$f_{Group-BP} = \frac{R_{NA}}{R_{A-BP}}, \quad f_{Group-I} = \frac{R_{NA}}{R_{A-I}} \quad .$$

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5. Method or apparatus according to claim 4, wherein for initialisation at the beginning of encoding a picture sequence said weighting factors $f_{Group-BP}$ and $f_{Group-I}$ are set to:

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$$f_{Group-BP} = \frac{1}{2}, \quad f_{Group-I} = \frac{1}{10} \quad.$$

6. Method or apparatus according to claim 4 or 5, wherein based on a number $\hat{R}_{Group-BP}$ or $\hat{R}_{Group-I}$ of target bits for a current one of said groups, the frame target bit number $\hat{R}_{A-BP}$ or $\hat{R}_{A-I}$ for the anchor frame is:

$$\hat{R}_{A-BP} = \frac{\hat{R}_{Group-BP}}{(1 + N_{NA} \cdot f_{Group-BP})} \quad \text{or} \quad \hat{R}_{A-I} = \frac{\hat{R}_{Group-I}}{(1 + N_{NA} \cdot f_{Group-I})} \quad, \text{ respectively,}$$

wherein N_{NA} denotes the number of non-anchor frames inside that current group, and whereby a corresponding accurate macroblock-layer rate control is used.

7. Method or apparatus according to one of claims 4 to 6, wherein the non-anchor frame or frames of a current one of said groups are encoded using a fixed quantisation step size of $Q_{NA} \approx 1.2 \cdot \overline{Q_A}$, where $\overline{Q_A}$ denotes the average quantisation step size that was used for encoding the anchor frame of that group.

8. Method or apparatus according to one of claims 4 to 7 wherein, after a current one of said groups has been encoded completely, said weighting factors $f_{Group-BP}$ and $f_{Group-I}$ are updated in that weighting factors for said current group are determined by

$$\tilde{f}_{Group-BP}(n_{Group-BP}) = \frac{1}{N_{NA} \cdot R_{A-BP}} \cdot \sum_{k=1}^{N_{NA}} R_{NA}(k) \quad \text{or}$$

$$\tilde{f}_{Group-I}(n_{Group-I}) = \frac{1}{N_{NA} \cdot R_{A-I}} \cdot \sum_{k=1}^{N_{NA}} R_{NA}(k) \quad, \text{ respectively,}$$

wherein $R_{NA}(k)$ is the number of used bits for the k-th non-anchor frame inside said current group, R_{A-BP} and R_{A-I} are the number of bits used for encoding the anchor frames as P/B-frame or as I-frame, respectively, and $n_{Group-BP}$ and $n_{Group-I}$ are continuously increasing indi-

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ces for said weighting factors,
and wherein the weighting factors to be used for follow-
ing groups are each calculated as corresponding average
values of the weighting factors used for several, e.g.
5   five, of the last encoded groups.

9. Method or apparatus according to claim 4 wherein, if In-
tra frames are coded rarely, both said weighting factors
$f_{Group-BP}$ and $f_{Group-I}$ are updated at the same time by
10   using an adaptively controlled weighting factor f_{BP-I} =
R_{A-BP}/R_{A-I}, which specifies the estimated bit-rate ratio
of anchor frames coded as P/B-frames and anchor frames

coded as I-frames, such that $f_{Group-I} = \dfrac{f_{Group-BP}}{f_{BP-I}}$.

15   10 Method for digitally decoding an encoded picture se-
quence, wherein the frames (FRM) of said picture sequence
are arranged in macroblocks (MB) containing pixel blocks
and the frames were encoded in bi-directionally-predic-
tive and predictive and/or intra coding types denoted B,
20   P and I, respectively, and wherein adaptively, for the
purpose of overall bit rate control, a specific frame
target number of bits was assigned to each one of these
coding types, and wherein said overall bit rate control
included a frame-layer rate control and a macroblock-
25   layer rate control which macroblock-layer rate control
had selected macroblock quantisation parameters,
wherein a target number of bits was assigned to anchor
frames only, or to each group of frames consisting of a
single anchor frame and at least one non-anchor frame,
30   and wherein anchor frames (P, I) were coded using macro-
block-layer rate control (10) by adaptive macroblock
quantisation (12) parameters, and non-anchor frames (B)
were coded without macroblock-layer rate control (10) by
using fixed macroblock quantisation (12) parameters,
35   said method including the step of:

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    -   decoding said anchor frames (P, I) using correspondingly
        adaptive macroblock quantisation parameters, and decoding
        said non-anchor frames (B) using fixed macroblock quanti-
        sation parameters.

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Abstract

Rate control mechanisms for video encoding aim to provide
the best possible video quality while keeping given condi-

5   tions on transmission rate and decoding delay. In order to
achieve a constant video quality, the anchor and non-anchor
frames of different frame types (I, P, and B) are encoded
using a different number of bits. However, since video se-
quences generally contain widely varying picture content and

10 previously coded frames are used to predict a given frame, a
suitable assignment of frame target bit rates is hard to de-
termine, especially for non-anchor frames. According to the
invention, non-anchor frames are coded using a fixed quanti-
sation parameter. Since the quantisation parameter used for

15 the encoding of non-anchor frames is directly derived from
the average quantisation parameter of the previously encoded
anchor frame, such approach ensures a constant video qual-
ity. Beside of that, the complexity of the rate control
strategy is reduced, because no macroblock-level rate con-

20 trol is applied for the encoding of non-anchor frames.

Fig.1

Fig. 1